CERTIFICATE

By Authority Of
THE UNITED STATES OF AMERICA
Legally Binding Document

By the Authority Vested By Part 5 of the United States Code § 552(a) and Part 1 of the Code of Regulations § 51 the attached document has been duly INCORPORATED BY REFERENCE and shall be considered legally binding upon all citizens and residents of the United States of America. *HEED THIS NOTICE*: Criminal penalties may apply for noncompliance.

This Document Posted By
Public.Resource.Org, Inc.,
a California Nonprofit
Organization.

Not Affiliated Or
Authorized by ASTM
or by the United States
Government

Document Name: ASTM G26: Standard Recommended Practice for Light- and Water-Exposure Apparatus (Xenon-Arc Type) for Exposure of Non-metallic Materials

CFR Section(s): 16 CFR 1201.4(b)(3)(ii)

Standards Body: American Society for Testing and Materials

APPROVED

Official Incorporator:

The Executive Director
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

Designation: G 26 – 70

Standard Recommended Practice for
OPERATING LIGHT- AND WATER-EXPOSURE APPARATUS (XENON-ARC TYPE) FOR EXPOSURE OF NONMETALLIC MATERIALS[1]

This Standard is issued under the fixed designation G 26; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 This recommended practice covers the basic principles and standard operating procedure for light- and water-exposure apparatus employing a xenon-arc light source.

1.2 This recommended practice does not specify the exposure conditions best suited for the material to be tested, but is limited to the method of obtaining, measuring, and controlling the conditions and procedures of the exposure. Sample preparation, test conditions, and evaluation of results are covered in ASTM methods or specifications for specific materials.

NOTE 1—Attention is called to ASTM Recommended Practice G 23, for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials,[2] ASTM Recommended Practice G 25, for Operating Enclosed Carbon-Arc Type Apparatus for Light Exposure of Nonmetallic Materials,[2] ASTM Recommended Practice G 27, for Operating Xenon-Arc Type Apparatus for Light Exposure of Nonmetallic Materials,[2] and ISO Recommendation No. 759, Document ISO/TC 61 (Secretariat).

NOTE 2—The values stated in U.S. customary units are to be regarded as the standard. The metric equivalents of U.S. customary units may be approximate.

2. Significance

2.1 Several types of apparatus with different exposure conditions are available for use. No single operating procedure for light- and water-exposure apparatus can be specified as a direct simulation of natural exposure. This recommended practice does not imply expressly or otherwise an accelerated weathering test.

2.2 Since the natural environment varies with respect to time, geography, and topography, it may be expected that the effects of natural exposure will vary accordingly. All materials are not affected equally by the same environment. Results obtained by use of this recommended practice shall not be represented as equivalent to those of any natural weathering test until the degree of quantitative correlation has been established for the material in question.

2.3 Variations in results may be expected among instruments of different types or when operating conditions among similar type instruments vary within the accepted limits of this recommended practice. Therefore, no reference shall be made to results from use of this recommended practice unless accompanied by Section 5, or unless otherwise specified in a referenced procedure.

3. Apparatus

3.1 *Water-Cooled Type:*

3.1.1 The apparatus employed shall utilize a water-cooled xenon-arc lamp as the source of radiation and shall be one of the following four general types, or their equivalent:

3.1.1.1 *Type A*—Water-cooled xenon-arc apparatus, 2500-W, 20-in. (508-mm) diameter specimen rack, automatic control of temperature and cycles, manual control of humidity.[3]

---

[1] This recommended practice is under the jurisdiction of ASTM Committee G-3 on Deterioration of Nonmetallic Materials.

Current edition effective April 13, 1970. Originally issued 1964 as E 239. Replaces E 239 – 69 T. Redesignated G 26 in 1970.

[2] *Annual Book of ASTM Standards*, Part 30.

3.1.1.2 *Type AH*—Same as Type A, except with automatic instead of manual control of humidity.[3]

3.1.1.3 *Type B*—Water-cooled xenon-arc apparatus, 6000-W, 37.75-in. (959-mm) diameter specimen rack, automatic control of temperature and cycles, humidity not controlled.[3]

3.1.1.4 *Type BH*—Same as Type B, except with automatic humidity control.[3]

NOTE 3—In the commercial descriptions of the four types, the term "cycle" is defined as the time intervals of light, darkness, and water spray that are specified differently according to the different testing methods.

3.1.2 The xenon arcs employed shall be of the high-pressure, water-cooled type and shall employ an inner and outer filter glass to contain and direct the flow of cooling water through the lamp and to filter out undesired wavelengths of radiation. For the purposes of this recommended practice, the xenon-arc lamp shall be equipped with a quartz xenon burner tube, an inner borosilicate filter glass, and an outer borosilicate filter glass with lower cutoffs at 275 nm.

3.1.3 To prevent contamination and to minimize the formation of deposits on the burner tube and the filter glasses, distilled or deionized water shall be circulated through the lamp at a minimum flow rate of 100 gal (378 liters)/h. By the use of a cartridge demineralizer in the line just ahead of the lamp, the water shall be redemineralized before being recirculated through the lamp. The recirculated lamp water shall be cooled without contaminating it by the use of a heat-exchange unit, employing either tap water or refrigeration as the heat-transfer medium.

3.1.4 Since xenon-arc lamps, like all gas discharge lamps, with continued use will have a progressive drop in radiation output and since filter glasses will change in their transmission characteristics, provision shall be made in the apparatus for progressively increasing the wattage of the lamp to minimize changes in the intensity of the radiation at the face of the sample. The greatest change in both the xenon burner and filter glasses occurs in the first 40 h of use. For this reason, preaged burners and filter glasses for that period of time are recommended for critical testing when a more rapidly changing rate of intensity is undesirable. For routine testing on a comparative basis, the 40 h of preaging may be omitted.

3.1.5 The 2500-W xenon-arc lamp through suitable reactance transformers and electrical equipment shall be operated on an a-c power supply at 208 to 250 V, from 2000 to 3000 W. The following are the recommended wattages for various periods of use of the 2500-W xenon burner tube:

Time, h	Power, W
Under 100	2000
From 100 to 300	2250
From 300 to 600	2500
From 600 to 1000	2750
Over 1000	3000

Because of their change in transmission it is recommended that outer borosilicate filter glasses be discarded and no longer used after 1500 h of use and that inner borosilicate filter glasses be discarded and no longer used after 300 h of use. A 2500-W xenon burner tube should be discarded and no longer used after 1500 h of use.

3.1.6 The 6000-W, xenon-arc lamp through suitable reactance transformers and electrical equipment shall be operated on an a-c power supply at 208 to 250 V, from 5500 to 6500 W. The following are the recommended wattages for various periods of use of the 6000-W xenon burner tube:

Time, h	Power, W
Under 100	5500
From 100 to 500	5750
From 500 to 1000	6000
From 1000 to 1500	6250
Over 1500	6500

Because of their change in transmission, it is recommended that outer borosilicate glass filters be discarded and no longer used after 2000 h of use and that inner borosilicate glass filters be discarded and no longer used after 400 h of use. A 6000-W xenon burner tube should be discarded and no longer used after 2000 h of use.

---

[3] Available from Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago 13, Ill. Model 25-W meets the requirements of Type A. Models 25-WT and 25-WR meet the requirements of Type AH apparatus. Model 60-W, 60/SMC, 60/DMC, and 60/XW meet the requirements of Type B. Models 60-WR, 60-WRC, 60/SMC-R, 60/SMC-RC. 60/DMC-R, 60/DMC-RC, 60/XW-R, and 60/XW-RC meet the requirements of Type BH apparatus.

3.1.7 A cylindrical frame between the xenon arc and the outer enclosure of the apparatus shall support specimen holders or test specimens so that they face the arc. In apparatus employing the 2500-W xenon lamp, the specimens in holders shall be at a distance of 10.0 ± 0.125 in. (254 ± 3 mm) from the vertical line passing through the center of the arc with no part over 4 in. (100 mm) above or below the horizontal plane passing through the center of the arc. In the apparatus employing the 6000-W xenon-arc lamp, the specimens in holders or mounted on the rack shall be at a distance of 18.875 ± 0.125 in. (459 ± 3 mm) from the vertical line passing through the center of the arc with no part over 9 in. (229 mm) above or below the horizontal plane passing through the center of the arc. In apparatus employing the 6000-W lamp, the specimens shall be mounted both above and below the horizontal center line of the arc. In order to provide uniform exposure conditions over their surface, the position of the test specimens shall be changed daily. The rotation of specimen position in the rack shall be in four steps, employed in the same sequence, from upper to lower specimen row and inverted in both specimen rows. If the time of exposure is less than 4 days, all specimens in a given series shall be positioned at the same level, either upper or lower, if sufficient space in available. The specimen rack shall rotate at 1 ± 0.1 rpm.

3.1.8 Testing temperatures shall be measured and regulated on the basis of a black-panel thermometer unit that is mounted on the specimen rack so that the face of the unit is in the same relative position and is subjected to the same influences as the test specimens. The black-panel thermometer unit shall consist of a stainless-steel panel about 2.750 by 5.875 by 0.0375 in. (69.9 by 149.2 by 0.95 mm), to which is mechanically fastened a stainless-steel bimetallic dial-type thermometer. This thermometer shall have a stem about 0.156 in. (3.9 mm) in diameter with a 1.75-in. (44.5-mm) dial. The sensitive portion extending about 1.5 in. (23.1 mm) from the end of the stem shall be located in the center of the panel about 2.5 in. (63.5 mm) from the top and about 1.875 in. (47.6 mm) from the bottom of the panel. The face of the panel with the thermometer stem attached shall be finished with a baked-on black glossy enamel having good resistance to light.

3.1.9 A blower unit in the base of the apparatus shall provide a flow of air through the test chamber and over the test specimens. Control of specimen and black-panel temperature shall be accomplished by thermostatic control of the temperature of the constant volume of air from the blower. Black-panel temperatures shall be read through the window in the test chamber door without opening the door.

3.1.10 The apparatus shall be equipped with a spray unit as covered in Figs. 1 and 2. The specimen spray unit and all components of the specimen spray system when used with tap water may be fabricated from copper or brass but preferably should be of stainless steel, plastic, or other material that does not react with the water. If demineralized water is employed, the water-spray system must be of stainless steel, plastic, or other material that does not recontaminate the water.

3.1.11 In Type B apparatus the relative humidity of the air in the test chamber passing over the test samples is not automatically controlled but is that produced by evaporation of water in the bottom of the test chamber and from water sprayed on the test samples and specimen rack by the specimen spray. Relative humidity in the Type B apparatus is measured by wet- and dry-bulb thermometers mounted in holders on the specimen rack, so that their sensitive portion is in the same relative position as the face of the test specimens but shielded from the light.

3.1.11.1 Types A, AH, and BH apparatus are additionally equipped with an electrically operated water-vaporizing unit for adding moisture to the air as it passes through the conditioning chamber in the base section of the apparatus prior to its entry into the test chamber. In Type A apparatus, the vaporizing unit when manually turned on operates continuously while the apparatus is in operation, and the temperature of the water with which it is supplied is not controlled. In

Types AH and BH apparatus the operation of the vaporizing unit is automatically controlled by a wet-bulb thermostat. By the use of thermostatically actuated electric immersion heaters, the temperature of the water supplied it, is automatically controlled. One set of dry-bulb, wet-bulb, and water-temperature thermostats controls while the arc lamp is in operation; a second set of dry-bulb, wet-bulb, and water-temperature thermostats controls during periods of darkness when the arc lamp is off. Control automatically shifts from one set of thermostats to the other as the arc lamp is turned on and off by the cycle control unit. In Types A, AH, and BH apparatus, relative humidity is measured and controlled on the basis of wet- and dry-bulb thermometers located in the air stream at its point of exit from the test chamber. Types A, AH, and BH apparatus when operated without the vaporizing unit and electric water-immersion heaters provide essentially the same conditions of relative humidity as are produced in Type B apparatus.

3.1.12 The apparatus shall include equipment necessary for measuring and controlling the following:

3.1.12.1 Wattage of the xenon-arc lamp,

3.1.12.2 Black-panel temperature,

3.1.12.3 Water spray pressure and temperature,

3.1.12.4 Operating schedule or cycle,

3.1.12.5 Exposure time, and

3.1.12.6 Relative humidity (Types A, AH, and BH only).

3.2 *Air-Cooled Type:*

3.2.1 The apparatus employed shall use an air-cooled xenon-arc lamp as the source of radiation and shall be one of the following two types, or their equivalent:

3.2.1.1 *Type C*—Air-cooled xenon-arc apparatus, 1500 W, 6.2-in. (15.8-cm) diameter specimen rack, with automatic control of cycles and humidity.[4]

3.2.1.2 *Type D*—Air-cooled xenon-arc apparatus, 4500 W, 14.2-in. (36.0-cm) diameter specimen rack, with automatic control of temperature, cycles and humidity.[4]

3.2.2 The xenon arcs employed shall be of the medium-pressure, air-cooled type and one or more filters shall be fitted between light source and samples to filter out undesired wavelengths of radiation. A combination of filters recommended by the manufacturer shall be used to simulate (*1*) sunlight in the open, (*2*) sunlight behind window glass, or (*3*) any other simulated solar irradiation condition desired.

3.2.3 All gas discharge lamps have a progressive drop in radiant output with continued use. Although design improvements in Types C and D minimize this drop in output, these xenon arcs must still be exchanged for new ones after 1500 h of use. Filter glasses need not be exchanged for new ones after use because they are pre-aged until optically stable.

3.2.4 Specimen holders shall rotate around the arc, describing a cylindrical surface, so that specimens may face, or be turned opposite, the arc. No part of the specimens shall be above or below the ends of the arc. Repositioning of specimens from upper, center, or lower positions is usually unnecessary because of the uniformity of intensity from top to bottom of the specimen holders. The specimen rack shall rotate at 5.2 ± 0.1 rpm in Type C and 3.7 ± 0.1 rpm in Type D.

3.2.5 Testing temperatures shall be measured and regulated on the basis of a black-panel thermometer unit that is mounted so that the face of the unit is in the same relative position and is subjected to the same influences as the test specimens. The black-panel thermometer unit shall consist of a stainless steel panel about 1.9 by 8.0 by 0.04 in. (48 by 200 by 1 mm) to which is mechanically fastened a stainless steel bimetallic dial-type thermometer. Temperature at the center of the panel shall be sensed by the thermometer. The face of the panel shall be finished with a baked-on black glossy enamel having good stability to light.

3.2.6 A blower unit in the base of the apparatus shall provide a flow of air through the test chamber and over the test specimens. Control of specimen and black-panel temperature shall be accomplished by thermostatic control of the temperature of the constant volume of air from the blower. Black-panel temperature shall be read through the window in the test chamber door without opening the door.

---

[4] Available from Quarzlampen GmbH, 6450 Hanau/Main, West Germany. Domestic distributor is Carl Zeiss Inc., 444 Fifth Ave., New York, N.Y. 10018.

3.2.7 The apparatus shall be equipped with a system to spray the specimens uniformly with water. This system should be of stainless steel, plastic, or other material that does not react with or contaminate the water employed.

3.2.8 Relative humidity in the test chamber shall be measured and controlled by a contact hygrometer. Water shall be vaporized and diffused to enrich the air with water and produce the required humidity.

3.2.9 The apparatus shall include equipment necessary for measuring and controlling the same parameters as listed for water-cooled xenon arcs.

4. Procedure

4.1 Check to be sure that the apparatus is in good running order at the start of each test or 100-h period of operation of the lamp and that it is equipped with a clean xenon burner tube and filter glasses with the total number of hours of use not exceeding the recommended maximum number of hours for each.

4.2 Place the test specimens either directly on the rack or in specimen holders on the rack so that they are supported in the proper vertical alignment. Completely fill the rack either with dummy specimens or holders filled with dummy specimens in all spaces on the rack not filled with test specimens.

4.3 Unless otherwise specified by the detailed requirements of the material being tested or by mutual agreement, insert the proper cam in the cycle meter so that the apparatus produces an operating schedule or cycle of 102 min of light only, followed by 18 min of light with spray, repeated for the duration of the test. Adjust the controls of the apparatus so that during the 102 min of light only, after equilibrium is reached, the black-panel temperature is maintained at 145 ± 5 F (63 ± 3 C). In Type B apparatus during the light-on period, the relative humidity is not controlled but is that which is produced by evaporation of water from the bottom of the test chamber and from the specimen spray. In Types A, AH, and BH apparatus, adjust the controls so that during the 102 min of light only the relative humidity, after equilibrium is reached, is 30 ± 5 percent and during the 18 min of light with spray the relative humidity is not controlled but is that which is produced by the evaporation of water from the specimen spray.

4.4 According to the type of apparatus, use either two or four F-80 nozzles (Figs. 1 and 2) in the specimen spray and operate at a pressure of 18 to 25 psi (1.3 to 1.8 kgf/cm^2), measured at the nozzle. Unless otherwise specified in the applicable ASTM method or material specification, the pH of the water shall be 6.0 to 8.0 and the water shall not leave an objectionable deposit or stain on the specimens after continued exposure in the apparatus. The temperature of the water shall be 60.8 ± 9 F (16 ± 5 C), and recirculation of the water shall not be permitted unless the recirculated water meets the above requirements. Pass the specimens through the spray once in each minute or revolution of the rack during the spray period. Allow the water to strike the test specimens in the form of a fine spray equally distributed over the specimens.

4.5 When mutually agreed upon or when called for by the applicable ASTM method or detailed material specification, Types A, AH, and BH apparatus with automatic control of humidity may alternatively be operated on a cycle of 102 min of light only followed by 18 min light with spray, repeated for a total of 18 h. Follow the 18-h period by 6 h without light or spray. During the 18-h period of light and spray, the black-panel temperature, except when the specimen spray is on, shall be 145 ± 5 F (63 ± 3 C) and the relative humidity of the air 50 ± 5 percent. During the 6-h period of darkness without spray, the black-panel temperature shall be 75 ± 5 F (24 ± 3 C) and the relative humidity of the air in the test chamber 95 ± 4 percent.

5. Report

5.1 The report shall include the following:

5.1.1 Type and model of exposure device,

5.1.2 Type of light source,

5.1.3 Age of filters,

5.1.4 Flux density at sample location, W/m^2

5.1.5 Spectral irradiance at sample location, $W/m^2 \cdot \mu m$

5.1.6 Elapsed exposure time,

5.1.7 Light/dark-water-humidity cycle employed,

5.1.8 Operating black-panel temperature,

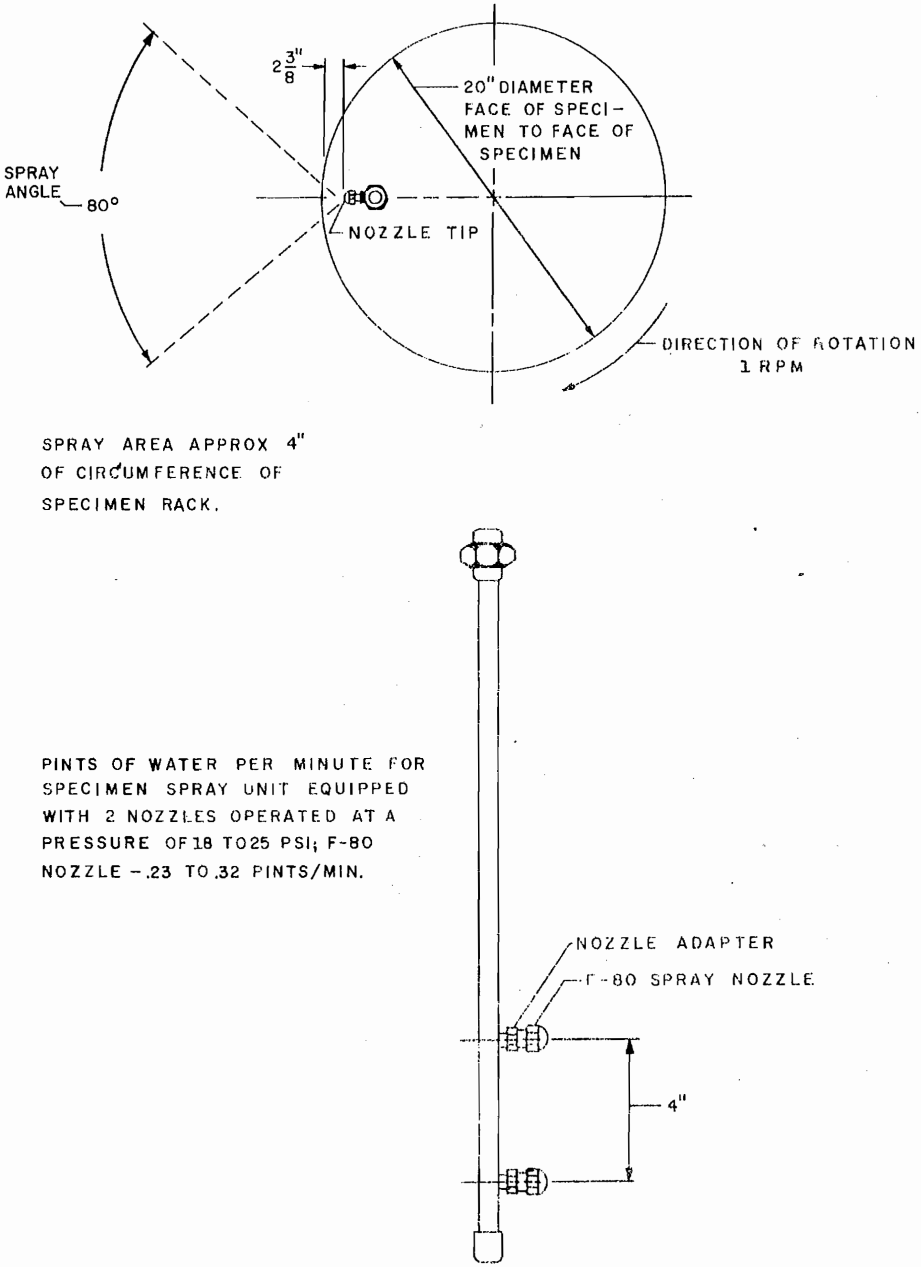
5.1.9 Operating relative humidity,

5.1.10 Type of spray water,

5.1.11 Type of spray nozzle, and

5.1.12 Specimen relocation procedure.

NOTE 4—When direct measurement of flux density and spectral iradiance can not be made, data supplied by the manufacturer shall be substituted.


2 3/8"
20" DIAMETER FACE OF SPECIMEN TO FACE OF SPECIMEN
SPRAY ANGLE 80°
NOZZLE TIP
DIRECTION OF ROTATION 1 RPM
NOZZLE ADAPTER
F-80 SPRAY NOZZLE
4"

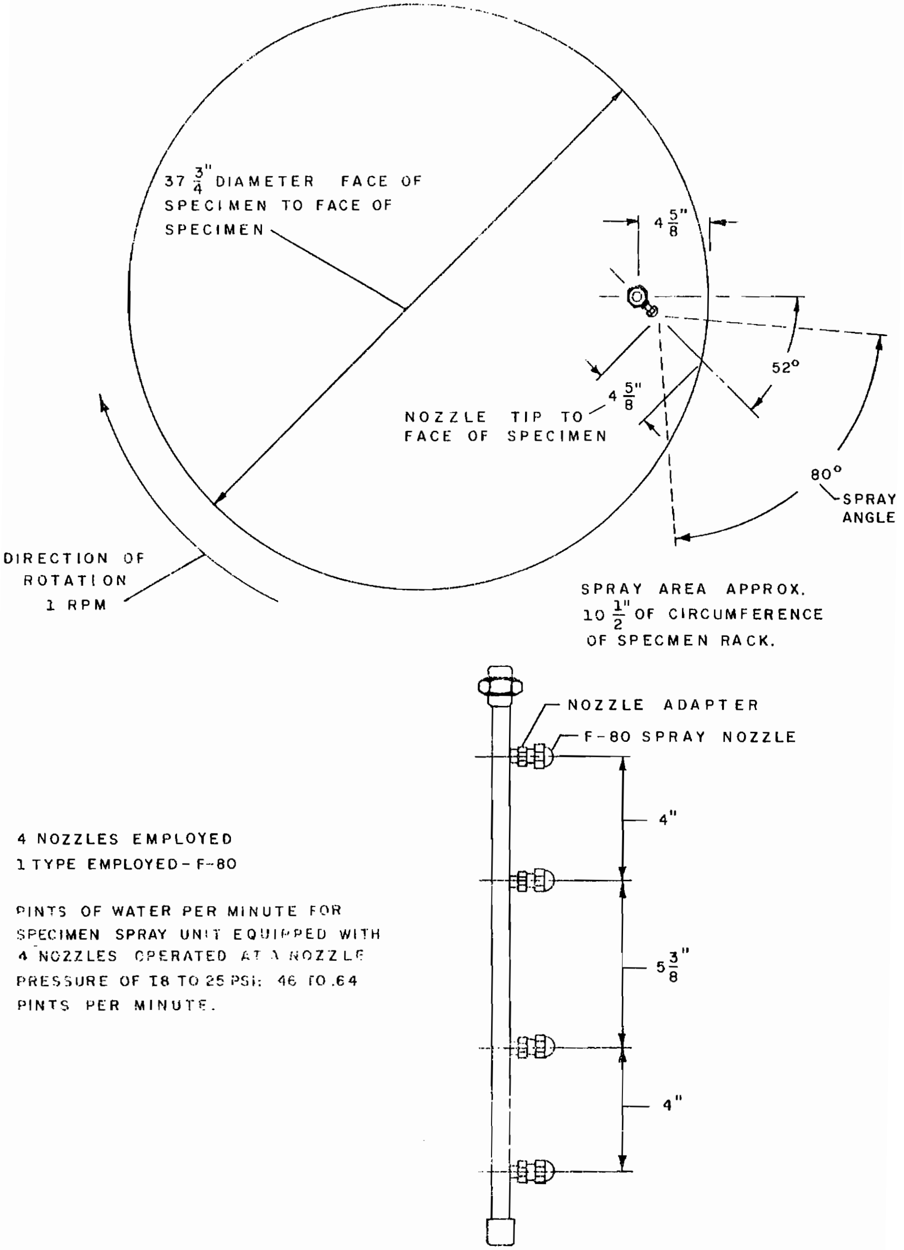
SPRAY AREA APPROX 4" OF CIRCUMFERENCE OF SPECIMEN RACK.

PINTS OF WATER PER MINUTE FOR SPECIMEN SPRAY UNIT EQUIPPED WITH 2 NOZZLES OPERATED AT A PRESSURE OF 18 TO 25 PSI; F-80 NOZZLE -.23 TO .32 PINTS/MIN.

Metric Equivalents

2 3/8 in.	60.325 mm
4 in.	101.6 mm
20 in.	508 mm
18 psi	1.3 kgf/cm^2
25 psi	1.8 kgf/cm^2
0.23 pt	0.109 liter
0.32 pt	0.152 liter

FIG. 1 Specimen Spray Arrangement for Type A and AH Apparatus.


37 3/4" DIAMETER FACE OF SPECIMEN TO FACE OF SPECIMEN
4 5/8"
4 5/8"
NOZZLE TIP TO FACE OF SPECIMEN
52°
80°
SPRAY ANGLE
DIRECTION OF ROTATION 1 RPM
SPRAY AREA APPROX. 10 1/2" OF CIRCUMFERENCE OF SPECMEN RACK.
NOZZLE ADAPTER
F-80 SPRAY NOZZLE
4"
5 3/8"
4"
4 NOZZLES EMPLOYED
1 TYPE EMPLOYED - F-80
PINTS OF WATER PER MINUTE FOR SPECIMEN SPRAY UNIT EQUIPPED WITH 4 NOZZLES OPERATED AT A NOZZLE PRESSURE OF 18 TO 25 PSI: 46 TO .64 PINTS PER MINUTE.

Metric Equivalents

4 in.	101.6 mm
$4^5/_8$ in.	117.48 mm
$5^3/_8$ in.	136.52 mm
$10^1/_2$ in.	266.7 mm
$37^3/_4$ in.	958.85 mm
18 psi	1.3 kgf/cm^2
25 psi	1.8 kgf/cm^2
0.46 pt	0.218 liter
0.64 pt	0.304 liter

FIG. 2 Specimen Spray Arrangement for Type B and BH Apparatus.